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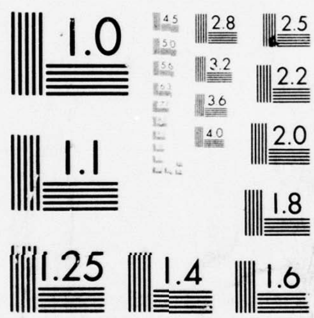

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FOREIGN TECHNOLOGY DIVISION

AERONAUTICAL KNOWLEDGE
(SELECTED ARTICLES)

EDITED TRANSLATION

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Weather and Aviation Safety
-- A Sketch on a Civilian Plane Trip

Written by Chii Fan

Early in the morning, the sky was densely covered with dark clouds, whose gloominess made me feel as though my heart was enveloped by a layer of dark clouds too. According to the schedule, I was supposed to finish the next part of my trip today. With the weather like this, I feared that the plane would not be able to leave on time. Nevertheless, I still managed to arrive at the airport punctually. Having an hour yet to go before departure, I strolled toward the information booth in the waiting room. A girl with two queues on her hair was recording something on a chart wherein, as I walked forth and took a look, were written all the incoming and outgoing flights of different itineraries on that day, followed by remarks as to which flights were to take off as scheduled and which flights had to be delayed, etc. Out of curiosity, I asked her why certain flights could depart on time, whereas others could not. It was due to the fact, she replied smilingly, that the weather standards varied for different pilots. Observing that I did not fully understand her reply, she explained patiently to me what she meant by weather standards for pilots. For each model of aeroplanes, different weather standards were assigned to different pilots compatible with their individual navigation proficiency and experience. When the weather at a certain time fell below the specified standard for a particular pilot, he was not allowed to fly.

"Isn't there a certain kind of 'all-weather' pilots?", I pursued, remembering having come across this term in a magazine.

"This term is not applicable to civilian aviation", she continued to explain. "The so-called 'all-weather' is actually a relatively-speaking term. Nature is unpredictable. There are a number of natural phenomena that can directly affect a flying mission. Serving as a socialistic transportation enterprise, the Chinese civilian aviation industry always puts safety ahead of everything else when carrying out its missions."

"How, then, can one tell which natural phenomena affect aviation and which do not?", a comrade who was standing next to us raised a question. Other passengers in the waiting room found the subject very amusing, so they all crowded around us. Realizing that everybody was interested, the girl decided that she might as well give us a talk on the relationship between weather and aviation.

Various Effects of Weather on Aviation Safety

The effects of weather on aviation can generally be divided into three types. The first type involves the natural phenomena that affect the views of the pilots, such as low clouds, precipitations, fogs, and dust-storms, which affect the safety of aeroplanes during take-off and landing. The second type involves the natural forces that are directly exerted on the aeroplanes or their steering surfaces. They cause navigation difficult. Sometimes serious consequences can ensue when the pilot fails to control the aeroplane, or when the structural strength of the aeroplane cannot endure such adversities, as in the cases of thunderstorms or turbulent currents, or strong gales during take-off and landing, etc., where violent disturbances are experienced. The third type involves the phenomenon of freezing that can lead to changes in the streamlines of the aeroplanes, whose dynamic properties

in the air will consequently be impaired.

Obstruction of Pilots' Views

In step with the progresses of scientific technology, facilities for aiding aerial navigation are approaching perfection. Nowadays, large airports are well-equipped with all kinds of navigation guidance facilities and aviation and landing aids. There is a kind of facility especially used for the so-called blind-landing operation. One is easily led to think, as the name suggests, that with this kind of facility the pilot could perform his landing with his eyes closed. This is not so, however. Although the pilot can rely on his radio communication systems and all kinds of navigation guidance instruments during his entire flight to reach his destination accurately even under circumstances where he may not be able to see the ground at all, he still has to rely on his own eyes to survey his surroundings and to judge where to touch the ground during his landing operation. If in this critical period the pilot's view is obstructed, landing will be made very difficult, and serious consequences can result. Statistics indicate that 90% of the accidents in aerial transportation in the world took place during the take-off and landing stages, with the majority of these cases associated with landing. In order to ensure the safety of aeroplanes during take-off and landing, pilots are assigned different weather standards compatible with their levels of training in each airport, consideration being taken as to how well-equipped and in what geographical conditions the airport is. For each pilot specifications of the minimum cloud height and visibility for take-off and landing are given. In common practice, there are two classes of weather standards, simply called Class I and Class II. The general standard specifications of cloud height and visibility are 100-200 meters and 1-2 kilometers respectively. The existing lowest specifications of

cloud height and visibility for Class I weather standards in the best-equipped airports in the world are 30 meters and 300 meters respectively. To carry out aviation with these specifications requires compatible equipments on board the aircraft and a very skillful pilot.

Aeroplanes under External Forces

Comrades having first-hand experience in aviation know that aeroplanes in flight sometimes experience disturbances which cause great discomfort to the passengers, especially in the summertime when flying over desert areas. The reason is that as the sandy surfaces on the ground are being heated up by the sun, the temperature of the layer of air next to the ground increases. The heated air then rises sharply, sets up a large convection of air, and thus creates unstable currents in the sky. Aeroplanes passing over these regions will encounter disturbances. Another situation in which violent disturbances are felt is when the aircraft flies into thick clouds, rainy clouds, or thunderstorm active regions. These disturbances not only cause discomfort to the passengers, but more importantly is the fact that each aeroplane has a certain designed limit in strength, so when this limit is exceeded by the violent disturbance force acting on the aeroplane, the aeroplane will suffer structural damage and at extreme cases will even break up in the air. Therefore, when the pilots encounter great disturbances in flight, they usually adopt the measure of changing the aeroplane altitude in order to avoid the violent disturbance regions.

On the ground, wind can affect directly the take-off and landing of aeroplanes. Accordingly, there are wind direction and wind speed specifications in the weather standards for each airport. For a particular model of aeroplanes, when the

wind direction and wind speed exceed the specified standards, take-off and landing are not allowed. It is because under this circumstance, the force of the wind acting on the steering surfaces of the aeroplane is so much greater than the strength of the controlling gears that either steering will be difficult or the aeroplane will be damaged.

Impairment of the Streamlines of Aeroplanes

Even in a hot summer, it is possible for ice-formation to occur on the body of an aeroplane in flight. The fact is that the atmosphere derives its temperature from radiations coming from the ground that gets heated by the sun. Thus, the atmospheric temperature decreases with increasing altitude. In general, in the altitude range attainable by aeroplanes, the decrement rate is about 0.65°C per 100 meters on the average, so when the surface temperature is about 30°C in the summertime, the air temperature at an altitude of 5000-6000 meters is generally below zero. An aeroplane travelling in cold air is likely to have ice formed on the windward surfaces of its chilled body when it enters clouds or precipitation regions. The danger of ice formation lies mainly in the fact that the ice layers tend to change the streamlines of the aeroplane and thus impair its dynamical properties in the air by increasing its frontal resistance as well as its weight. Consequently, the aeroplane cannot maintain its altitude and speed. Ice formation can also occur at the air inlet passages of the engine, the radiator, and other places, and renders the engine inoperative. If the ice pieces fall off and drop into the air linlet passages, hit and damage the blades of the compressor that are rotating at high speed, serious consequence will result. All modern large transportation aircrafts are equipped with anti-freeze facilities. Under conditions conducive to ice formation, the anti-freeze

system will be turned on to warm up places susceptible of ice formation so that freezing is discouraged, and in case thin layers of ice have been formed, to melt them away immediately. In order to avoid ice formation on the aircrafts, pilots usually adopt the measure of circumvening clouds and rainy regions that are favorable to ice formation.

Finally, the girl confidently reassured us, "Even though Nature's caprices can give rise to some unfavorable effects on aviation, they can be forecasted. With the advances in our country's aviation meteorology, and through the diligence of the meteorology department, accurate weather forecasts can be provided for aviation at any time. You can totally depend on the assurance of safety in our country's aviation."

On the runway, the silvery white aeroplane was receiving its last touch-up. The crew members of the aeroplane were receiving the passengers warmly by the staircase. In a few minutes, I was going to begin another pleasant journey in the sky.

Figure 1
Natural Phenomena That Affect the View of the Pilot

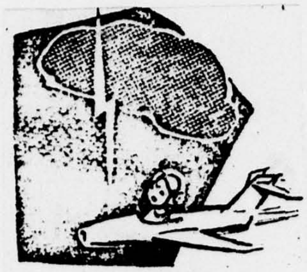

Figure 2
Effects of the Natural Forces on the Structure of the Aeroplane

Figure 3 Streamlines of the Aeroplane Got Distorted Due to Ice Formation

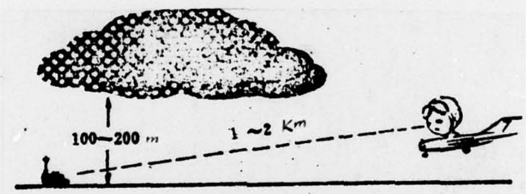

Figure 4 General Weather Visibility Standard Required for Landing

Figure 5 Disturbances Felt by Aeroplane over Desert Areas

Figure 6 Disturbances Avoided by Altering the Flying Altitude

Figure 7 Circumvening Rainy Areas

Illustration by Li Kia.

Earthquake Prediction by Artificial Satellites
(From : Overseas Aeronautic Technology)
Written by Kuo Fang Ts'ing

Abstract

Earthquake is a common natural phenomenon. By carefully observing its forewarnings with the help of all kinds of effective methods, earthquake forecasts can be made possible. So far, the use of artificial satellites as a means for earthquake prediction is still at the exploratory stage, which provides us with only some background information. Although it is helpful in the prediction of earthquakes at their early and intermediate stages, the problem of giving forecasts close to and immediately before the occurrence of earthquakes is far from being solved. By consulting overseas sources, this article presents a brief introduction to the current status of the satellite method for earthquake prediction.

In recent years, the subject of earthquake prediction by satellite has received much attention. A number of countries have already embarked on the research and experimentation in this field. Their work can be summarized to be carried out along two directions.

The first approach involves the surveying and photographing of large areas of land on earth by artificial satellites in order to study the macro-structures of the terrains and to locate potential earthquake sites.

Earthquake is a natural phenomenon, whose occurrence is related to the geomorphology of the earth, especially the distribution of faults. Aerospace technology has provided us with novel and convenient methods to survey landforms and

and distribution of faults from the air.

Surveying and repeated photographing of large areas of land on the earth's surface are facilitated by the use of satellites orbiting at altitudes of several hundred kilometers. Geological structures and landforms that cannot be reflected in narrow-range photographs are now clearly reflected in photographs of wider range.

During the Sixties, the American Imperialists took a large amount of photographs of the earth from satellites and airships for political and military purposes. After intensive study, they found that these photographs not only had military values but also had significance in some civilian and economic applications, one of which is earthquake prediction. For example, the pictures of the California region in the United States taken from the Apollo 7 and Apollo 9 manned airships revealed that there were three active cross-shaped faults in the vicinity of the Los Angeles area. With this information, an earthquake forecast was issued in an astronomy meeting in 1969, which was later fulfilled in February, 1971. In order to further encroach on other nation's resources, the American Imperialists devised the Earth Resources Satellite program in 1970, in which surveying of geological structures and landforms, understanding of the distribution of faults, and the search for earthquake prediction methods, were also included as important items for which research was to be carried out.

After two years of research, the American Imperialists launched into space the first Earth Resources Satellite on July 23, 1972. The satellite weighed 892 kilograms, and moved in an orbit with a period of 103.2 minutes. The orbit had its perigee and apogee 905 and 918 kilometers above ground

respectively, and an angle of inclination of 99.125 degrees. The satellite carried three multi-spectrum imagers and a station of spectrograph operative in four spectral bands. After ten days in orbit, the imagers ceased working due to failure in the electrical circuits, while the spectrograph continued to take pictures of places all over the globe. Distribution of some faults on the earth's surface were clearly visible in these pictures, which, when combined with the analysis of historical information, led to the discovery of new faults and of the activities of the faults. There were seven recorded earthquakes in Alaska in the United States, but only five faults were found on the old geological map, which explained the occurrence of only two of the earthquakes. Later, through the analysis of the satellite pictures, seven new faults were discovered, thereby explaining the remaining five earthquakes. In 1972, after the great earthquake in Ecuador, a cross-shaped fault was also found in the local satellite pictures.

The second approach involves the continuous monitoring of the anomalous wobble of the earth's rotation axis and of the deformation of the active faults with the use of satellite technology in combination with other precision distance measurement methods.

Investigations indicate that the wobble of the earth's rotation axis can often be linked to the occurrence of violent earthquakes. When the dates of the twenty-two violent earthquakes are checked against the dates on which wobbles of the earth's rotation axis were perceived between 1957 and 1968, one finds that there are matches between fifteen pairs of them, equivalent to a percentage of 68. Moreover, this kind of anomalous wobble appeared one to eighteen days before the occurrence of five out of the six most violent earthquakes,

and eight to fifteen days before the occurrence of three out of the seven violent earthquakes. Therefore, the anomalous changesin the earth's rotation can be viewed as forewarnings to the occurrence of violent earthquakes. As soon as this kind of forewarning is procured by means of accurate measurements, one can determine, together with the monitoring of the deformation of active faults, potential sites of imminent earthquakes,thus attaining the goal of earthquake prediction. Of course, the reliability of this kind of analysis has yet to be confirmed.

For more than ten years, the American Imperialists have launched numerous geodetic-surveying satellites into space, the main objective being to locate, to within an accuracy of one meter, the positions of the targets for their strategic weapons. Since the rate of the crustal motion is quite small at many places, being less than five centimeters a year, measurement accuracy obtained previously by geodetic-surveying satellites still falls short of meeting that required for earthquake prediction.

On May 4 last year, the American Imperialists launched a spherical laser geodetic-surveying satellite into space, especially for the purpose of measuring with high precision the slight deformation of the earth-crest, in order to monitor anomalous changes in the earth's rotation and the activities of the regional faults, and to explore the possibility of obtaining accurate earthquake prediction. The structure of the satellite was rather simple: It consisted of two aluminium hemispheres screwed onto a center copper shaft, and carried 426 laser reflectors on its surface. Because of its small size (diameter 60 centimeters), heavy weight (about 410 kilograms), and high orbit altitude (the orbit was a quasi-circular polar orbit 5900 kilometers above ground), its

motion was very stable. In the course of measurement, a laser beam was emitted from the ground station to the satellite, which then reflected the laser pulses back to the ground station by means of its laser reflectors. Thus, by measuring the time taken by the laser pulses to go forth and back to the ground station, the actual movement of the spot on which the ground station was situtated could be calculated. According to the sources, the complete work using this laser geodetic-surveying satellite will be finished by 1985. From the data and the mathematical model for the crustal motion thus obtained, it is possible to construct a seismic map, and in the next twenty years forecasts on local earthquake zones can be made. The crux of this measurement technique lies in the requirements that the satellite orbit be very stable, and the measurement of the orbit be very accurate.

On February 6, 1975, France launched a small laser geodetic-surveying satellite into space. Christened "Little Star", the satellite weighed 47 kilograms, measured 24 centimeters in diameter, and carried 60 laser reflectors. Its operational principles and objectives were similar to the one launched by the American Imperialists.

In conclusion, the work on earthquake prediction by satellites is still at the exploratory and experimental stage. So far, preliminary work indicates that one can obtain important background information for the prediction of earthquakes. Although it is helpful in the prediction of earthquakes at their early and intermediate stages, the problem of giving forecasts close to and immediately before the occurrence of earthquakes is still far from being solved.

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